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Growth Performance, Carcass, Haematology and Serum Metabolites of Broilers as Affected by Contents of Anti-nutritional Factors in Soaked Wild Cocoyam (*Colocasia esculenta* (L.) Schott) Corm-based Diets

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ABSTRACT

The performance of hydro broiler chickens fed graded levels of soaked wild cocoyam (*Colocasia esculenta* L. Schott) corms (SWCC) as a partial substitute for maize were investigated in a 28 day study. One hundred and twenty (120) 4 week old hydro broiler chickens of similar average weight were randomly assigned to 4 dietary treatments. Each treatment had 3 replicates of 10 birds each. Four experimental diets were formulated such that SWCC replaced maize at 0.00, 10.00, 20.00 and 30.00% in the diets. The birds were fed *ad libitum* and clean drinking water was provided throughout the period of the study. Parameters investigated include the growth performance, carcass characteristics, haematological and serum biochemical indices. Result of the growth performance showed no significant ($p>0.05$) difference in average weekly feed intake. Average weekly weight gain and cost per kilogram feed decreased ($p<0.05$); FCR increased ($p<0.05$) with increased inclusion of SWCC in the diets. Cost of feed per kilogram weight gain (CFPKWG) of birds fed on all SWCC-based diets were significantly ($p<0.05$) lower than control. Result of carcass analysis indicated that live weight, plucked weight, Eviscerated Weight (EW), Dressed Weight (DW), GIT and organs (kidney, liver and gizzard) were significantly ($p<0.05$) affected by dietary treatments. The highest ($p<0.05$) EW (72.91%) and DW (64.78%) of the control were similar ($p>0.05$) to EW (71.51%) and DW (63.33%) of 10% SWCC; but higher ($p<0.05$) than those of 20 and 30% SWCC. Organ weights reflected their roles in handling residual anti-nutritional factors in SWCC. Variations obtained in all the serum biochemical indices and haematological parameters investigated were not significant ($p<0.05$). This may suggest adequacy of the nutrients and absence of deleterious health implications for the birds. It was concluded that SWCC can economically replace 30% of maize in the diets of broiler finishers with no deleterious effects on carcass quality and health of the birds.

Key words: Soaked wild cocoyam corms, hydro-broilers, replacement, performance, health status

INTRODUCTION

Feed represents the major cost of poultry production. Cost of ingredients could be as high as 80% of the total cost of production of the finished feed (Longe, 2006). Inadequate production of feeds has been found to be one of the major factors limiting the development and expansion of poultry business (Emenalom, 2004). Birds are known to eat in order to satisfy their energy requirement (Ranjhan, 1980; Ewing, 1995). The implication is that the energy content of a diet would determine the extent of consumption of such feed. Since, the energy component of a feed is

usually high, a reduction in the cost of energy would translate to reduced cost of feeding livestock (Ayuk *et al*., 2009). In the developing countries of the world, cereals and other grains serve as food for man, feed for livestock and other industrial uses. This has led to high cost of cereals and invariably high cost of livestock production.

Adequate production of animal products and consumption of protein of animal origin at the optimal level for the teaming population of these developing countries will be a mirage except alternatives are found to cereals. Roots and tubers including corms of cocoyam readily provide these alternatives. Some cultivars of wild cocoyam are not directly competed for as human food resources. These are more likely to be available for use at lower costs. Presence of anti-nutritional factors (ANFs) in cocoyam (Panigrahi, 1996; Esonu *et al*., 2000) could limit their use. Soaking in water has been recommended to alleviate the problem (Marfo and Oke, 1988; Sonaiya, 1995; Iyayi and Losel, 1999). Therefore, this study evaluated the effects of graded levels of soaked wild cocoyam (*Colocasia esculenta* L. Schott) corms on growth performance, carcass and health status of hydro-broiler finisher chickens.

MATERIALS AND METHODS

The processing, nutrient and anti-nutritional contents of the soaked wild cocoyam (*Colocasia esculenta* L. Schott) corms were as in Olajide *et al*. (2011).

Chemical analysis: Analysis of the proximate chemical composition of the experimental diets was according to the method of AOAC (1995). Nitrogen Free Extract (NFE) was determined by difference and Metabolizable Energy (ME) calculated according to the procedure of Pauzenga (1985) as:

$$ME\ (kcal\ kg^{-1}) = 37 \times Protein\ (\%) + 81.8 \times Fat\ (\%) + 35.5 \times NFE(\%)$$

Experimental diets: Four experimental diets were formulated with partial substitution (weight for weight) of maize with SWCC. Diet 1(Control) had no SWCC. Diets 2, 3 and 4 were formulated to contain 10, 20 and 30% SWCC.

Site of the experiment: The feeding trial was carried out at the rearing section of the Poultry Unit of the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria. The location of the study is 7°27' N and 3°45' E at altitude 200-300 m above sea level; mean temperature of 25-30°C and the average annual rainfall of about 1255 mm.

Management of the experimental birds: Wood shavings of about 20 cm thick layer served as the litter and artificial light (electric bulb) provided to encourage the birds eat at night. The rearing house was previously washed, disinfected, allowed to dry and rest before the birds were moved in from brooder section. One hundred and twenty hydro broiler finishers were used for this study. The birds at 4 weeks of age were randomly distributed to four dietary treatments of three replicates each. There were 30 birds of similar average weight per diet. The birds were weighed and feed intake recorded weekly. Feed and water were provided *ad libitum*.

Carcass analysis: Forty eight birds were randomly selected at the rate of 12 birds per diet for carcass analysis at the end of feeding trials which lasted for 4 weeks. The selected birds were

starved overnight and their live weights recorded. The birds were slaughtered by severing the jugular vein, hung upside down for proper bleeding. Each of the carcasses was thoroughly bled, scalded, de-feathered and eviscerated according to the procedures of Jones (1984). The carcass and internal offal designated as Gastro Intestinal Tract (GIT) were weighed and recorded. The plucked, eviscerated and dressed weights were also taken and expressed as percentages of live weight. The organ weights were calculated and expressed as percentages of carcass weight. Carcass evaluation was carried out at the Meat Science Laboratory of the University of Ibadan, Nigeria.

Haematology and biochemical indices: At the end of feeding trial, twenty four birds (6 birds per dietary treatment) were selected and bled by the jugular vein using hypodermic needle with syringe. Blood was drained into two different carefully labeled bottles for haematological and serum metabolite investigation. The blood samples for haematological parameters were collected into bottles pretreated with Ethylene Diamine Tetra Acetic acid (EDTA), an anti-coagulant. Blood samples for biochemical indices were collected into another sample bottles containing no EDTA. Serum biochemical indices investigated include total protein, globulin, albumin, albumin: Globulin ratio, cholesterol and glucose. Packed Cell Volume (PCV), Red Blood Cell count (RBC), White Blood Cell (WBC) and haemoglobin were determined by Wintrobe's microhaematocrit, improved Neubauer haemocytometer and cyanometaemoglobin methods, respectively. Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corupuscular Haemoglobin Concentration (MCHC) were calculated as described by Jain (1986).

Statistical analysis: Data obtained were subjected to analysis of variance (ANOVA) using SAS Statistical Package, SAS (1999). The means were separated using Duncan multiple range test.

RESULTS AND DISCUSSION

The proximate composition, metabolisable energy and contents of anti-nutritional factors in soaked wild cocoyam (*Colocasia esculenta* L. Schott) corms are presented in Table 1. The report revealed that corms of cocoyam contain anti-nutritional factors which is agreement with the submissions of Agwunobi *et al.* (2002) and Preeti (2003).

Table 1: Proximate composition, metabolisable energy and anti-nutritional factors in soaked wild cocoyam corms

Parameters	SWCC
Dry matter (%)	88.06
Crude protein (%)	6.56
Crude fibre (%)	3.75
Ether extract (%)	0.95
Ash (%)	2.86
Nitrogen free extract (%)	73.94
Metabolisable energy (kcal kg^{-1} DM)	2945.30
Anti-nutrients	
Condensed tannins (g/100 g DM)	0.18
Hydrolysable tannins (g/100 g DM)	0.04
Phytate (g/100 g DM)	0.08
Oxalate (g/100 g DM)	0.21
Hydrocyanide (ppm)	7.57
Saponin (g/100 g DM)	0.22

SWCC: Soaked wild cocoyam corms, Source: Olajide *et al.* (2011)

The gross composition and determined nutrient composition of the experimental diets are presented in Table 2. The replacement levels were 0, 10, 20 and 30% of maize with soaked wild cocoyam (*Colocasia esculenta* L. Schott) corm. The determined nutrient composition reflected the original compositions of maize and SWCC. The diets were formulated in such a way that the nutrient and energy requirements of the birds were met as recommended for the tropics (Olomu, 1976, 1995).

Table 3 revealed that the highest ($p<0.05$) weight gain (304.48 g/b/week) was obtained in birds fed the control diet. This significantly ($p<0.05$) reduced to 275.31, 240.37 and 215.33 g/b/week, respectively for birds fed 10, 20 and 30% SWCC-based diets. The same trend was observed in the cost per kilograms feed. The lowest ($p<0.05$) FCR (2.56) was obtained in birds fed the control diet and the highest (3.59) in birds fed 30% SWCC-based diets. Cost (N127.86) of feed per kilograms weight gain recorded in birds fed the control diet was significantly ($p<0.05$) higher than N105.97, N117.81 and N125.95, respectively from birds fed 10, 20 and 30% SWCC-based diets. Ezieshi and Olomu (2004) reported that feed cost per kg live weight of broilers on palm kernel cake diets and maize offal were lower than that of the control. Feed intake was not significantly ($p>0.05$)

Table 2: Gross composition of experimental finisher diets fed to hydro broilers

	Diets			
	1	2	3	4
Item	SWCC (0%)	SWCC (10%)	SWCC (20%)	SWCC (30%)
Ingredients				
Maize	50.00	45.00	40.00	35.00
SWCC	0.00	5.00	10.00	15.00
PKC	8.50	8.50	8.50	8.50
Wheat offals	12.50	12.50	12.50	12.50
GNC	10.00	10.00	10.00	10.00
Soyabean meal	12.00	12.00	12.00	12.00
Palm oil	0.40	0.40	0.40	0.40
Fish meal (72%)	3.00	3.00	3.00	3.00
Bone meal	1.50	1.50	1.50	1.50
Oyster shell	1.35	1.35	1.35	1.35
Salt	0.20	0.20	0.20	0.20
Premix	0.25	0.25	0.25	0.25
Methionine	0.15	0.15	0.15	0.15
Lysine	0.15	0.15	0.15	0.15
Total	100.00	100.00	100.00	100.00
Determined nutrient composition (%)				
Dry matter	89.54	89.70	89.53	89.58
Crude protein	20.45	20.25	20.20	19.95
Crude fibre	4.36	4.53	4.58	4.65
Ash	5.14	5.24	5.46	6.56
Ether extract	3.87	3.66	3.57	3.50
Nitrogen free extract	55.72	56.02	55.72	54.92
ME (kcal kg^{-1} DM)	3051.28	3037.35	3017.49	2974.11

SWCC: Soaked wild cocoyam corms, *Composition of premix: 2.5 kg of premix contains: Retinol acetate (10000000 iu), Vit. D3 (2000000 iu), Vit. E (15000 iu), Vit. B (3000 mg), Niacin (15000 mg), Vit. B6 (3000 mg), Vit. B12 (10 mg), Vit. K3 (2000 mg), Biotin (20 mg), Folic Acid (500 mg), Calcium pantothenate (800 mg), Chlorine Chloride (250000 mg), Manganese (75000 mg), Iron (25000 mg), Copper (5000 mg), Zinc (70000 mg), Selenium (150 mg), Iodine (1300 mg), Magnesium (100 mg), Ethoxyquine (500 g), BHT (700 g)

Table 3: Performance characteristics of hydro broilers fed soaked wild cocoyam corms as substitute for maize

	Diets					
	1	2	3	4		
Parameters	SWCC (0%)	SWCC (10%)	SWCC (20%)	SWCC (30%)	SEM	COV
Feed intake (g/b/week)	778.19	761.88	771.49	773.33	19.80	5.13
Weight gain (g/b/week)	304.48^{a}	275.31^{b}	240.37^{c}	215.33^{d}	18.08	13.97
Feed conversion ratio	2.56^{d}	2.76^{c}	3.21^{b}	3.59^{a}	0.22	14.19
Cost per kg feed (N)	50.01^{a}	38.35^{b}	36.70^{c}	35.05^{d}	3.07	15.34
Cost of feed per kg						
Weight gain (N)	127.86^{a}	105.97^{d}	117.81^{c}	125.95^{b}	4.93	8.26
Mortality (%)	3.33	3.33	3.33	3.33	-	-

SWCC: Soaked wild cocoyam corms, $^{a, b, c, d}$Means in the same row with different superscripts are significant ($p<0.05$), SEM: Standard error of the means, COV: coefficient of variation

affected by the dietary treatments. The non significant dietary effects on feed intake could point to better ability of these older birds (finishers) to tolerate contents of anti-nutritional factors in the SWCC-based diets. This agrees with the submissions of Bedford (2006) and Egena (2006) that older birds are able to tolerate ANFs than younger ones.

Absence of anti-nutritional factors in the control diet which would have allowed for effective utilization of nutrients in it was responsible for highest weight gain and lowest FCR of birds fed the diet. The increasing contents of these anti-nutritional factors with the increasing levels of substitution could also account for decreased Weight Gain (WG) and increased Feed Conversion Ratio (FCR) obtained. Similar decreased WG and elevated FCR have been linked to contents of ANFs in the diets (Ahmad *et al*., 2000; Kumar, 2003). Also, Esonu *et al*. (2000) recorded similar trends with another cultivar of wild cocoyam corms, wild variegated cocoyam (*Caladium hortilanum*). Cost of a kilogram of feed across the dietary treatments reflects the price of maize which was higher than that of SWCC at the time of purchase. Because of this lower price of SWCC than maize, despite the lower WG and higher FCR of the birds fed on SWCC-based diets than those on control, the cost of feed per kg weight gain of those on SWCC were still lower than control.

Result of the carcass characteristics analysis of broilers is presented in Table 4. It indicated that live weight, plucked weight, eviscerated weight, dressed weight, GIT and organs (kidney, liver, gizzard) were significantly ($p<0.05$) affected by dietary treatments. There was no significant ($p>0.05$) difference across the dietary treatments in bled weight and abdominal fat. The highest bled weight (96.94%) and abdominal fat (2.03%) was diet 1 while the lowest bled weight (95.63%) and abdominal fat (1.47%) was diet 4. The trend observed in the live weight was as a result of performance of the birds fed control and other diets. The highest eviscerated weight (72.91%) and dressed weight (64.78%) were obtained from birds fed the control diet which was not significantly ($p>0.05$) different from those fed 10% SWCC-based diets with respective values of 71.51% and 63.33% in the same order. These were, however, significantly ($p<0.05$) higher than those fed 20 and 30% SWCC-based diets. The higher eviscerated and dressed weights obtained in birds fed the control and 10% SWCC-based diets was indication that birds on these 2 diets produced more edible meat than others. This was a result of better utilization of the nutrients in the control diet with no anti-nutritional factors and 10% SWCC-based diet with lower contents of ANFs than

Table 4: Carcass characteristics of broilers fed soaked wild cocoyam corm-based diets

	Diets					
	1	2	3	4		
Parameters	SWCC (0%)	SWCC (10%)	SWCC (20%)	SWCC (30%)	SEM	COV
Live weight (kg)	1.97^{a}	1.78^{b}	1.58^{c}	1.52^{d}	0.11	12.71
Bled weight (%)	96.94	96.83	96.53	95.63	0.74	1.53
Plucked weight (%)	88.43^{ab}	86.28^{ab}	92.15^{a}	83.44^{b}	2.33	5.33
Eviscerated weight (%)	72.91^{a}	71.51^{a}	69.48^{ab}	65.47^{b}	2.08	5.95
Dressed weight (%)	64.78^{a}	63.33^{a}	60.19^{ab}	56.90^{b}	2.10	6.84
Gastro intestinal tract (%)	9.19^{ab}	8.49^{b}	11.99^{ab}	13.04^{a}	1.34	25.06
Abdominal fat (%)	2.03	1.64	1.48	1.47	0.28	33.09
Organ wt. (% of carcass)						
Kidney	0.96^{b}	1.16^{ab}	1.10^{b}	1.45^{a}	0.14	24.40
Lungs	0.87	0.85	1.02	1.13	0.10	20.51
Liver	3.35^{c}	3.31^{c}	3.82^{b}	4.27^{a}	0.24	12.63
Gizzard	2.75^{d}	3.48^{c}	3.88^{b}	3.99^{a}	0.34	19.43

SWCC: Soaked wild cocoyam corms, $^{a, ab, c, d}$Means in the same row with different superscripts are significant ($p<0.05$), SEM: Standard error of the means, COV: Coefficient of variation

20 and 30% SWCC-based diets. This result confirms earlier findings (Emiola *et al*., 2003) that reduced ANFs as a result of improved processing techniques enhanced birds performance. The increases observed in the weights of the gastro intestinal tracts with increased level of SWCC in the diets could be linked to the weight of undigested parts of the feeds. The ANFs increased with levels of substitution and have been reported to lower nutrients and dry matter digestibility (Onifade and Tewe, 1993; Alokan, 2000; Olajide *et al*., 2009). The offal percentages represented by GIT obtained in this study is at variance with the submission of Butcher *et al*. (1983) that offal percentages tend to increase as slaughter weight of animal increase. The highest kidney weight was obtained in birds fed 30% SWCC and similar liver weights obtained at 0 and 10% SWCC which increased with the contents of SWCC in the diets. This could be linked to the roles of these organs in elimination of metabolic wastes and toxins from the body. This result agrees with the report by Onyeyilli *et al*. (1998) that kidney and liver are primary organs of biotransformation in animals. Also, Voss *et al*. (1990) and Ewuola *et al*. (2003) have linked hypertrophy or hypotrophy of these organs to the presence toxin. The lowest gizzard of the birds on control diet which increased with SWCC in the diets reflected the extra muscular work required to process these diets with anti-nutritional factors including higher fibre than control. Similar anti-nutritional effect of Velvet beans on gizzard growth was reported by Carew *et al*. (2003).

Serum metabolites profiles of the birds are presented in Table 5. There was no significant ($p>0.05$) difference across the various dietary treatments in total protein, albumin, globulin, albumin: globulin ratio and glucose. The lowest globulin (3.83 g dL^{-1}) obtained in the control treatment numerically increased to 4.20, 4.39 and 4.48 (g dL^{-1}), respectively for birds fed 10, 20 and 30% SWCC-based diets. The highest cholesterol (134.54 mg dL^{-1}) was obtained from birds fed control diet which numerically reduced to 129.56, 122.45 and 116.34 mg dL^{-1}, respectively for birds fed 10, 20 and 30% SWCC-based diets. The non significant of most of these serum metabolites may indicate adequacy of nutrients especially CP. However, the increased globulin with contents of

Table 5: Serum metabolites of broilers fed soaked wild cocoyam corm-based diets

	Diets					
	1	2	3	4		
Parameters	SWCC (0%)	SWCC (10%)	SWCC (20%)	SWCC (30%)	SEM	COV
Total Protein (g dL^{-1})	6.13	6.57	6.95	6.99	0.80	6.88
Albumin (g dL^{-1})	2.29	2.37	2.55	2.51	0.11	8.68
Globulin (g dL^{-1})	3.83	4.20	4.39	4.48	0.75	35.49
Albumin: Globulin Ratio	0.60	0.93	0.59	0.57	0.19	54.97
Cholesterol (mg dL^{-1})	134.54	129.56	122.45	116.34	6.58	10.47
Glucose (mg dL^{-1})	133.06	121.03	127.53	127.70	4.48	7.04

SWCC: Soaked wild cocoyam corms, SEM: Standard error of the means, COV: coefficient of variation

Table 6: Haematology of broilers fed soaked wild cocoyam corm-based diets

	Diets					
	1	2	3	4		
Parameters	SWCC (0%)	SWCC (10%)	SWCC (20%)	SWCC (30%)	SEM	COV
Red blood cells (mm^3x106)	3.28	03.22	0.14	8.36	3.12	3.27
White blood cells (mm^3x103)	20.10	20.30	1.54	15.36	19.55	19.98
Packed cell volume (%)	27.00	28.33	0.91	6.54	27.67	28.00
Haemoglobin (g 100 mL^{-1})	9.40	09.37	0.23	4.75	9.27	09.47
Mean corpuscular volume (u)	82.75	88.02	5.54	12.73	91.15	85.77
Mean corpuscular haemoglobin						
Concentration (%)	34.98	33.25	1.09	6.44	33.49	33.80
Mean corpuscular haemoglobin (uug)	28.74	29.13	1.72	11.69	30.54`	29.01

SWCC: Soaked wild cocoyam corms, SEM: standard error of the means, COV: coefficient of variation

ANFs in SWCC in the diets was an indication of the need for defense system (immune response) to defend the body from these ANFs. The total protein, globulin, albumin and glucose fall within the values recommended for normal chickens (Mitruka and Rawnsley, 1977). The decreased cholesterol could also be linked to contents of saponins in SWCC. Saponins are known to bind with bile acids and cholesterol, thereby clean or purge these fatty compounds from the body, lowering the blood cholesterol level. Similar reports were given (Potter *et al*., 1979; Oakenfull, 1981; Akpodiete *et al*., 1997; Michael, 2005).

None of the haematological indices investigated was significantly ($p>0.05$) affected by dietary treatments (Table 6). The lowest WBC (19.55 $mm^3\times10^3$) was recorded in birds fed control diet. This numerically increased to 19.98, 20.10 and 20.30 $mm^3\times10^3$, respectively for birds fed 10, 20 and 30% SWCC-based diets. The numerical increase in WBC was as a result of the response of the defense mechanism of the birds to handle contents of ANFs in SWCC. However, the non significant values of these haematological parameters across all dietary treatments, coupled with values of PCV, Hb and total protein which fell within the recommended for normal chickens (Mitruka and Rawnsley, 1977) was an indication of adequate nutrition for these birds. Ikhimioya *et al*. (2000) and Oladele *et al*. (2001) linked lower values of these parameters to inadequate nutrition.

CONCLUSION

Results from this study indicated that maize could economically be replaced by 30% soaked wild cocoyam corms in the diets of broiler finishers without compromising the quality of the carcass and with no deleterious effects on the health status of the birds.

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